19 NOVEMBER 1979 (FOUO 6/79) 1 OF 1

JPRS L/8771

19 November 1979

Worldwide Report

NUCLEAR DEVELOPMENT AND PROLIFERATION

(FOUO 6/79)

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APPROVED FOR RELEASE: 2007/02/08: CIA-RDP82-00850R000200020032-2

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WORLDWIDE REPORT

NUCLEAR DEVELOPMENT AND PROLIFERATION

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CONTENTS

JAPAN

PROSPECTS GOOD FOR MAGNETIC RECOVERY OF SEAWATER U, LI

Tokyo NIKKAN KOGYO SHIMBUN in Japanese 13 Aug 79 p 3

[Text] The Institute of Physical and Chemical Research [IPCR] conducted research jointly with the group led by Prof Shoichi Okamoto of the Nagaoka Technical and Scientific University to successfully develop a magnetic trapping agent that would adsorb uranium, and thus brightened the prospects of the seawater uranium magnetic recovery technology which involves seawater uranium being adsorbed by a magnetic substance and then recovered by a magnet. This magnetic substance is a composite magnetically strong uranium trapping agent that is a combination of gamma/iron oxide and hydrated titanium oxide. Prof Okamoto will announce the research results to the Japan Society of Applied Magnetics in late October and he intends to collaborate with the research group, including Prof Koshiro Hashimoto of Chiba Institute of Technology, to seek, with the same magnetic substance as the basic element, a selective adsorbing agent for lithium which can be used as fuel for nuclear fusion.

The amount of uranium in seawater reaches from 4 billion to 4.5 billion tons. It is said that seawater contains 3.3 milligrams of uranium per ton of seawater. With this knowledge, the Ministry of International Trade and Industry during JFY 1979 began designing in detail a pilot plant that can recover 10 kilograms of uranium per year and it is scheduled to begin operating in JFY 1982.

However, technical development is still necessary and it is not yet clear whether the ideal of the recovery process for use with the pilot plant is the fixed-bed pump/column type or the current-flow multi-layered type.

In the fixed-bed process, the adsorbing agent is placed at a stationary position and seawater is brought into contact with it. At present, research on the pump/column type appears to be favored; however, the pump/column type has weaknesses, such as use of a granular adsorbing agent with a diameter of about 1 mm which results in pressure loss from resistance that is comparatively heavy and also the adsorbing rate is slow.

The adsorbing agent in the pump/column type considered to be most promising today is the composite adsorbing material, in the form of titanic acid carried on the surface of active carbon, which was developed at the Shikoku Government Industrial Research Institute of the Agency of Industrial

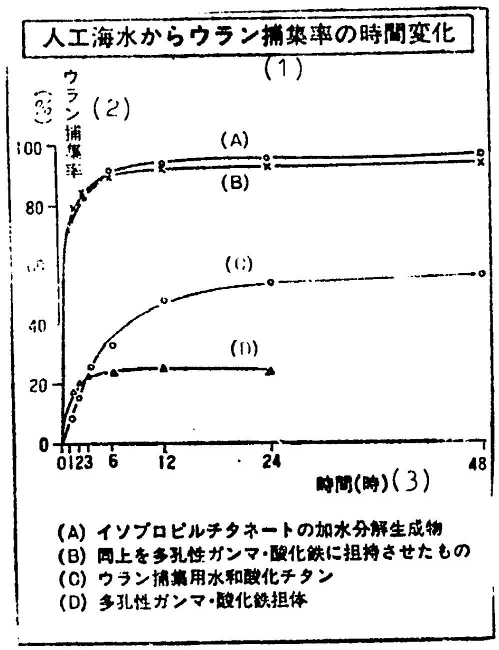
Science and Technology, but it is reported that, after a 10-day subjection to seawater flow, the amount of uranium recovered was about 200 micrograms for 1 gram of adsorbing agent. The Shikoku Government Industrial Research Institute has set a goal of increasing the production to five times or a daily output of 100 micrograms, but the outlook for this is not good.

The uranium collecting magnetic trapping agent developed at the IPCR is a powdery magnetic substance, 0.1 to 0.5 microns in diameter, that offers great prospects for achieving a high rate since, in a short period, it can adsorb the large amount of milligrams of uranium per 1 gram of adsorbing agent. Prof Okamoto, engaged in research and development of the magnetic trapping agent at the IPCR up until this spring, said, "Since quantitative data figures were not collected, an affirmation cannot be made now; but we are confident of recovering milligrams of uranium from 1 gram of this adsorbing agent."

The IPCR got interested in high speed solid-liquid separation, which is a characteristic of magnetic separation, and undertook to develop the system of concentration/separation recovery of matter by using magnetism. In magnetic filtration, the filtering resistance is high against magnetic particles and conversely extremely low against non-magnetic particles or the flow of fluids. The reduction of filtering resistance can be achieved with a fast rate and high efficiency of the filtration operation.

In this way, magnetic filtration, while it has numerous superior properties, is only compatible with magnetic substances, and therefore it has the weakness of not being usable with non-magnetic substances. The IPCR is considering a method conventionally considered impracticable, of pouring non-magnetic materials into solutions such as seawater and adding magnetic trapping agents and, after the adsorptive period, placing the materials in a magnetic separator/concentrator apparatus equipped with a 4-pole electromagnet and separating and concentrating the desired material along with the magnetic trapping agent.

Many techniques for transforming non-magnetic materials into magnetically active status have been in practical application. One example is activation practiced in waste water treatment. The method involves sprinkling inexpensive magnetically strong powder, such as ferrites or magnetites, on non-magnetic suspensed solids or utilizing heavy metallic ions with a strong magnetic precipitant. With these performances as reference, the IPCR undertook to develop strong magnetic particles that could adsorb uranium selectively and vigorously, and focused on porous gamma/iron oxide that can be obtained by heat dehydration of gamma/(lebidokurosaito). The material used is the spinel Fery magnet which, depending on its method of manufacturing, has the special characteristic of undergoing varied changes in magnetism and fine structure.



Key:

1. Time changes and percentage of trapped uranium from artificial seawater
2. Percentage of trapped uranium
3. Time (hours)

A. Hydrolytic product of isopropyl titanate
B. The above substance (A) carried on porous gamma/iron oxide
C. Hydrated titanium oxide used for trapping uranium
D. Porous gamma/iron oxide carrier

Experiments conducted on uranium scavenging from seawater revealed that the adsorptive characteristic of porous/gamma/iron oxide, used alone, is extremely low, as clearly shown by curve "D" on the attached chart. Organic titanium acid was then laid on the surface of this basic material and subjected to hydroiysis to form the composite magnetically strong uranium adsorbing agent of gamma/iron oxide--hydrated titanium oxide. The comparison of curve "B" for the characteristic of this sample with curve "C" for the hydrated oxide, which is currently marketed for uranium adsorption, clearly shows that the performance of the combined adsorptive agent is much better. Curve "A" is for the hydrolytic product of isopropyl titanate, the performance of which will hardly improve should it be combined with the basic material of gamma/iron oxide.

Along with development of this magnetic trapping agent, that has such outstanding properties, construction of a uranium concentrator/separator recovery apparatus has been in progress and completion of it is expected shortly. This system involves a "pulse current generator" that transmits electric current to the magnetic separator 4-pole electromagnet; a "magnetic filtration mechanism and analysis apparatus" that would measure the pressure changes of the magnetic filter section in order to analyze the rate and accuracy of magnetic separation, changes in the magnetic field, and the changes over time of the heavy metallic component liquids; and a "magnetic trapping agent injection and mixing apparatus" which will automatically inject the appropriate amount of magnetic trapping agent solution into the unseparated solution, agitate the mixture and then send it to the filtration section.

An outstanding feature of this system is the application of the 4-pole electromagnet, the nucleus of the system, after it was developed for focusing accelerator beams of a cyclotron by the engineering section of the IPCR. "At present, we are conducting a cost estimate of the system and there is still room for change and improvement," said Prof Okamoto, and to attain a much greater percentage of uranium recovery, he is considering using an electromagnet with higher performance in filtration, or further by adding a permanent magnet. Prof Okamoto stated that the manufacturers' cooperation would be sought to develop a permanent magnet with a high performance.

Furthermore the aim is to establish a method of removing and scavenging the heavy metals and other materials from the magnetic trapping agent, which had originally trapped the heavy metals and other materials during separation from the magnetic separation apparatus, and also a technique to recover and recycle the magnetic trapping agent. In any case, research and development for the practical utilization of the technology for seawater uranium recovery is being speeded up in West Germany, England and other countries of the world. In Japan, starting 10 years ago, the Japan Monopoly Corporation pioneered the undertaking with research and development, and today there is great activity to develop the adsorbing agent and the system, with the Metal Mining Agency of the Ministry of International Trade and Industry taking the lead and joined by Hitachi, Ltd and other manufacturing companies. Seawater is rich with uranium and other natural resources, such as lithium which in the future will be used as fuel for nuclear fusion. With the uranium recovery technology as base, it is hoped that the sphere of application of the magnetic separation technology will be expanded so that it will serve as the recovery technology for other natural resources.

9510
CSO: 5100

SOUTH KOREA

BRIEFS

AFRICAN URANIUM FOR SEOUL--The Korean government plans to develop uranium resources in Africa with private French companies. The state-run Korea Electric is already helping the development of uranium mines in Paraguay and the government wants more Korean private companies to participate in uranium projects in such uranium-rich countries as Australia, Canada and Paraguay. Korea's demand for nuclear fuel is about 100 tonnes a year, but if the power stations develop as planned, it will need 1,000 tonnes by 1986. It is hoped that nuclear energy will supply 37% of the country's needs by 1988, compared with 8.5% last year. [Text] [Hong Kong INSIGHT in English Oct 79 p 7]

CSO: 5100

COUNTRY SECTION FRANCE

POLITICS OF NUCLEAR POWER PLANT CRACKS UPDATED

Paris VALEURS ACTUELLES in French 15 Oct 79 pp 40-41

/Article by Francois Lebrette/

/Text/ Progress of detection equipment and union rivalry: two growing mirrors behind the "crack scandal."

"Electoral cracks?" Some EDF /French Electric Power Company/ officials are inclined to make a bet:

"We shall reach an agreement with the unions on charging the Tricastin and Gravelines reactors about 15 November, that is, after the union elections of 8 November."

On that day there is to be a renewing of the Administrative Council of the Central Fund for Social Activities of electric and gas company personnel. The stake is sizable: financed by withholding in the amount of 1 percent of the turnover of the EDF and GDF /French Gas Company/, the fund's budget is about 500 million francs. The fund has about 3,000 fulltime employees. The CGT /General Confederation of Labor/ has always had an absolute majority in the Administrative Council. The CFDT /French Democratic Confederation of Labor/ plans to contest this monopoly on 8 November.

In launching the crack affair on 21 September, Edmond Maire's power plant knew it was placing the CGT, reputed to be "pro-nuclear," in an awkward position. CGT members replied by going their rivals one better: the charging of the reactors, scheduled for the beginning of October, was blocked. The strike unleashed unilaterally by the CGT for Tuesday, 16 October, seems to stem from the same electoral counteroffensive: it is intended to show the personnel that the CGT is the only one able to defend its interests in a positive manner.

Last Tuesday, Francois Dutheil, secretary of the CGT federation of energy, announced that it would take about 3 weeks to inspect the cracks. His union could then declare itself reassured immediately after the elections.

In any case, there is shortsightedness in the attitude of the unions: if the cracks to which they are calling attention are really dangerous, it is less important to prevent charging the new reactors than to demand the shutdown of power plants of the same type (PWR /pressurized-water reactors/) already in operation in which the same defects would already have had time to show up: the two Fessenheim reactors hooked up in 1977, the three Bugey sections which got into operation this year, and the small Chooz plant on the Belgian border, which has been in operation since 1970.

However, this would be risking depriving the EDF of 4,500 megawatts this winter, whereas it is public knowledge that the installed horsepower is barely adequate to meet the demand and that the possibility of power cuts is not excluded. This is a responsibility no union wants to assume.

Are these cracks present in all PWR reactors? To be truthful, no one really knows. The only thing inspectors responsible for nuclear safety can say is that the first cracks were detected about a year ago in tanks under construction following the development of a new inspection technique, "radiography by supersonic focusing." It was not thanks to any union worker endowed with the eyesight of a lynx, as hearsay would have it.

"The more inspection equipment is perfected, the more imperfections we find," an engineer states. "If tomorrow we discover new inspection methods, we shall discover new faults at the same time."

Applied to tanks containing gas, radiography by supersonic focusing has revealed "faults" which would preclude the use of those tanks if the security regulations were the same as those of the electrical-nuclear sector.

In the case of reactor tanks it is a matter of "closed cracks" (EDF prefers to speak of "indications") located on the inside surface of tubes 22 centimeters thick. These cracks are overlaid with a triple layer of stainless steel 12 millimeters thick.

The catastrophic picture presented by the computer predicts the following development: first, because of stresses to which the defective piece is subjected (temperature of 350 degrees, pressure of 150 atmospheres), the crack is transmitted "by sympathy" from the ordinary steel to the stainless coating. From that time on, a "lightning-like" change would enable the crack to spread through the coating within 4 or 5 years. The result: a rust point on the inside surface of the pipe.

There is no question that such a point cannot be permitted to expand or even show up. Hence, the timing indicated by the EDF safety services and the Ministry of Industry. First, winter must pass; then the reactors must be charged. After that, profit simultaneously by the annual shutdowns, normally scheduled for recharging and checking for wear, to listen to what engineers call "the entrails" located in the reactor tank.

Equipment for detecting an enlarged crack already exists. Afterwards, the proper steps will be taken: if even one reactor tube shows the drastic picture presented by the computer, it would indicate the need to change the reactor's schedule of operation or shut it down completely.

The last step: send a robot into the tube capable of sanding the defective area and rewelding a stainless coating on the spot in question. This type of equipment is to be available in 2 years, long before any change in the cracks can become a rust point.

The Council of Information on Electronuclear Energy, chaired by Mrs Simone Veil, denounced the "lack of information" revealed by this affair on 2 October. The "responsible" administrations should have begun an investigation the moment the cracks appeared. A safety specialist states ironically:

"Reveal the existence of cracks before we are even able to evaluate their possible change? It is then that we would be labeled irresponsibles."

In reality, the scandal does not lie in any lack of information given by the EDF or AEC but rather in the fact that they are the only ones who provide information and that the individuals responsible are obliged to carry out an energy program which is dependent upon policy and therefore upon the government. Rather than take it out on those individuals, Mrs Veil's information council should have been able to perceive its own deficiencies due to the lack of investigative means. But it has never complained of that lack to the government.

8568
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FRANCE

PROPOSED NUCLEAR POWER SITE THREATENS PARIS WATER SUPPLY

Paris SCIENCE ET VIE in French Apr 79 pp 85-91

[Article by Jacqueline Denis-Lempereur: "Radioactivity Threatens Paris Water"

[Text] The EDF [French Electric Company] plans to build a nuclear powerplant upstream of Paris water sources. "Mathematical models" have foreseen everything --but hydrologists wonder about the catastrophic consequences from the ever-present possibility of leaks.

Plans for a nuclear powerplant at Nogent-sur-Seine have just been submitted to public inquiry after much controversy. At first, it will be a question of two 1,300-MW blocks--the initial plans called for four. The choice of site caused quite a stir. It was expected from the ecologists, but certain administrations were also concerned, which ought to be further taken into consideration.

Why was Nogent chosen? EDF was preparing to retire the thermal power stations feeding the Parisian region. Experts were predicting that consumption was going to double within 20 years. Nogent-sur-Seine could supply two regions--Champagne-Ardennes and Ile-de-France. Moreover, the site is located at the intersection of an important network of transmission lines linking Paris, Belgium, Alsace, and the Alps region. The transition will be inexpensive and easy. Finally, the land should not be too expensive, as it is located in a deserted, swampy area--periodically flooded in winter. In other words, it is ideal, at least in the eyes of the EDF engineers. The opinion of the Seine-Normandy Basin Agency is completely different. This water management agency sees a major drawback to the project--the power plant will be located less than 100 KM upstream of Paris.

This is the first time in the world that it has been decided to set up a nuclear plant so close to a large urban center. Outside of the danger it would represent in case of a major accident, an improbable eventuality but impossible to eliminate, it imperils the water supply of the Parisian region simply by operating. This heavily populated region consumes nearly

2 million m^3/day, with two origins--the rivers and water tables. While Paris is privileged to be supplied with an average of 50 percent well water, thanks to its canal works completed between 1860 and 1925, the nearest suburb receives only 2 percent well water. Therefore, mainly river water, after settling, filtration and treatment, flows in suburban faucets. Out of the 11 main river water treatment plants, 7 use waterfrom the Seine--6 between Melun and Paris and the seventh in Suresnes, just downstream from Paris. Their total production capacity reaches 1,780,000 m^3/d, while the three plants on the Marne and the one at Mery-sur-Oise total 1,220,000 m^3/d. As to the underground water, four large recovery fields are located along the Seine--Aubergenville, Croissy-le-Pecq, Ville-neuve-la-Garenne and, closer to Nogent-sur-Seine, la Grande Paroisse. Their total capacity is 500,000 m^3/d. Everyone knows that when catch basins are close to a river and the pumping rate is high, a cone of demand is formed in the water table and thus a large percentage of river water is drawn from the water table (up to 90 percent). What would happen in case of large-scale, accidental pollution of the Seine upstream of Paris? Upstream are several water collectors, water quality monitoring stations, which operate continuously. Their role is to transmit the alarm in case of particularly significant pollution. Supposing that there were a sufficient network of these stations and that they were sensitive to the type of pollution which would occur, the treatment plants would immediately stop drawing from the Seine and the catch basins would be stopped. Without sufficiently early notice, the problem would become singularly complicated, because it is technically very difficult and takes a very long time to repair a water treatment plant in which heavy pollution has contaminated all the basins and various circuits--a few days is sufficient for a drop of water to make its way from Nogent to Paris.

Once the entire process is stopped, Parisians still have a few reserves. Water consumption is irregular throughout the day or even the year, so the water distributors need to store a certain amount of water in reservoirs in order to respond to increased demand in peak moments. Thus, while average consumption in the Parisian region is around 2 million m^3/d, production capability is almost double that. Unfortunately, these reserves would only last a short time, and the situation would become critical after 24 hours. Proceeding along the sectors, which are not all supplied by the same network, the consequences would be more or less catastrophic. Thus, the city of Paris, with its resources and abundant reserves, could even give momentary aid to the most vulnerable suburb nearby. Althout it allows "emergency service" in case of incidents, the system of interconnections between the various networks is unfortunately not developed enough to face serious pollutions of long duration.

The problem becomes uniquely complicated due to the fact that the water resources presently in use will be insufficient in the years to come. To respond to these problems, the perfect of Ile-de-France, Mr Lanier, established a Committee of Experts in February 1977. In order to predict the capital's water needs, two working hypotheses were retained--a population increase which would reach 11.7 million inhabitants by the year 2000, and a steady population which would not exceed 9.9 million inhabitants. In either case, satisfaction of water needs will require mobilization of new resources--1,300,000 m^3/d by the year 2000 in the first case and 660,000 m^3/d by 1990 in the second case. To face these new needs, the Parisian population center can call upon unused subterranean resources, especially since the quality of river water has become quite mediocre and the norms to satisfy, as well as consumer requirements, have become more and more severe. Water drawn from the Seine in 1975 and 1976 did not conform to community standards--too much cadmium, lead and mercury. It is also becoming more and more difficult to treat river water. The effects of producing potable water in plants of ancient design are being felt.

Production capacity of the Ivry plant, which was about 250,000 m^3/d in 1950, has declined steadily since 1960 to an average of 75,000 m^3/d the last 4 years.

In order to attend to the most urgent things first and to guarantee good quality water to the Parisians, the Basin Financial Agency considers it indispensable to keep the lands of the Montereau water bed, capable of furnishing 600,000 m^3/d. This plan is not new and brings to mind the "jousts" between the quarry owners and the heads of water management, a problem recalled in Alain Peyrefitte's book, "The French Evil." The only problem is that this formidable reserve of good quality, potable water, the most significant reserve in the Seine basin, is located a few dozen kilometers downstream from Nogent-sur-Seine. Figuring in a Basin Agency document dating from July 1973, is a reserve area located some 100 meters from the site. In reality, all of the existing and future water supply network of the Parisian metropolitan area is threatened by the power plant. It is surprising that the public utility hearing was only open within a radius of 5 KM--as if this powerplant only concerned about ten communes!

Up to now, the administration has formally refused to set up industrial establishments in the alluvial plain. So why this deviation? "Even so, it is illogical to go and set up a nuclear power plant upstream of metropolitan water supply sources!" stated Gilbert Castany, a prominent hydrologist from the Bureau of Geologic and Mining Research. Castany, likewise part of the Committee of Experts set up by the perfect of Ile-de-France, added, "If, by mischance, there should be a major accident, the entire water table would be condemned, and all the Seine with it, as far as Havre, and the Parisian region would be completely deprived of water for a good long time." Even without envisioning the worst, the "habitual" risks tied to nuclear plants are worrisome. In a unanimous opinion of 18 March 1975, the Basin Committee focussed on "the risk of radioactive contamination of water tables used for human supply." Moreover, this same Basin Committee judged nuclear powerplants upstream from Paris "undesirable." Even the minister of the quality of life, Andre Janot at the time, stated, "The use and storage of chemical and radioactive products in the catch zone or upstream from it risk endangering the use of geologic structures of the region for the preparation of water destined for Parisian consumption." This problem is all the more serious as this vast natural reserve of good quality water is particularly fragile. According to the vulnerability map established by the BRGM [Bureau of Geological and Mining Exploration], the chosen site is part of the zones where water table vulnerability is greatest, due to risks of rapid propagation of pollution by the intermediary of surface streams which feed the water table. The water-soaked clay which is found under the alluvium and which constitutes the geologic substrate of the entire region is well fissured. While runoff speed for certain water tables located in impermeable, nonfissured rock does not exceed a few tens of centimeters per day, here it reaches 50 to 100 meters per day. Moreover, the covering clay does not give sufficient protection--although it may stop organic pollution, it would pass chemical and radioactive pollution.

In a 1974 document of the Finance Agency of the Seine-Normandy Basin, the hydrogeologic section denounces the danger of building a nuclear powerplant in the Seine valley, the effects of which would extend well beyond 5 KM. "When the water table is used for irrigation, the radioactive ions which have reached the water table could enter the plant-animal-man food chain in amounts very dangerous for the human organism." It would thus be a matter of the concentration phenomenon, a well known ecological law, which says that a pollutant accumulates in increasingly greater percentages as it passes from one link to the next in the food chain. Keeping in mind the feeding of the water table by the river, these risks could extend to irrigated areas much farther downstream. The same risks exist for the farms and prairies watered by rains carrying radio-isotopes released by the powerplant into the atmosphere.

The alluvium which covers the soil in these regions has a high retention capacity for strontium 90 and cesium 137. The lives of these elements, which are particularly dangerous because they replace calcium and potassium in the organism, are 28 years and 30 years, respectively. Are these fears really justified? Recall that the statement was filed by the EDF, which is judge in its own case. Certain Basin Agency experts call it the worst environmental impact statement ever made in Seine-Normandy. "Summary, insufficient studies!" despite EDF assurances to the Basin Delegation that the Nogent statement would be exemplary. The Basin Agency is not the only one to share this opinion. The conclusions of the Interservice Conference organized by the minister of industry to solicit the opinions of the various interdepartmenttal services, are along the same lines. "Numerous studies should have been more extensive." "It seems, however, that certain points which demand special precautions but which do not affect the basis of the project, were not studied by the EDF; for example, the effect of the powerplant on the pH of the Seine or the effects of sulfates on the irrigation of corn." As to the radioactive effects, the opinions of the services on the statement are split, since the Basin Delegation requested additional details, while the SCPRI [Central Protection Service Against Ionizing Radiations] judged certain elements "superfluous."

What are the pollution risks? First, there is chemical pollution. If not treated before use, the water drawn from the Seine would quickly incrust the cooling circuits with its carbonates and bicarbonates of calcium. To counter this, sulfuric acid is added, which transforms a large portion of the carbonates and bicarbonates into more soluble sulfates. Given the total volume of water treated, EDF foresees using nearly 34 metric tons of acid per day. After dilution in the huge discharge basin, a daily total of 37 metric tons of sulfates would thus be dumped into the Seine, plus the sludges, calcium carbonates and ferric chlorides discharged by the supplemental circuits.

But this methodical cleaning of the water circuits is not enough to insure perfect cleanliness. A multitude of tiny organisms, bacteria, algae and lichens are ready to take up residence there, threatening the yield of the plant. In order to kill these unwelcome organisms, injection of sodium hypochloride either periodically or continually in weak doses is called for; sodium hypochloride is nothing other than bleach and disinfectant. "It is hard to predict the required amount, for when biological parameters are involved, theory no longer suffices," affirm the researchers of the CTGREF [Technical Center for Rural Engineering and Waters and Forests] who participated in the environmental impact study. They had only 6 months to carry out their work on the entire hydrobiological part, at least the state of reference. Twenty pages total! They were given another study, concerning the conjectural point of view, but it was not brought to light until two years after the public utility statement. "We cannot predict, anyway," they admit, "we can only learn from experience."

The superb pike which still stock the waters in this area, one of those parts of the Seine richest in animal life, need only move their spawning grounds. It would seem the Basin Agency also fears the discharge of heavy metals, which are not even mentioned in the environmental impact report.

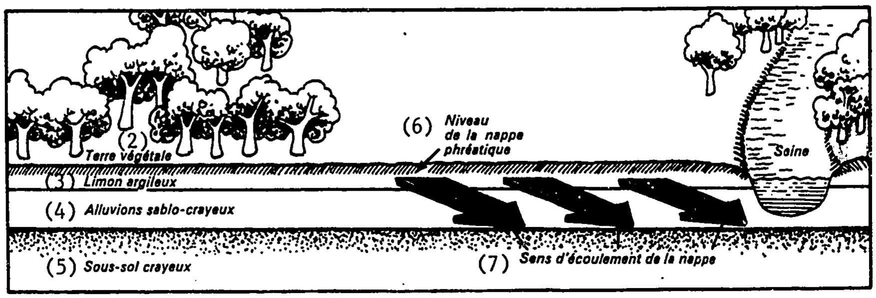
And then, there is thermal pollution. Warm water, although favorable to the development of phytoplankton, is not always propitious for aquatic organisms. Since the flow of the Seine at Nogent is insufficient during its lowest periods, the cooling system of the powerplant operates on a closed circuit. Drawing 4.5 m^3/s of water from the Seine, the powerplant returns 3 m^3/s of it some 200 meters farther downstream, while 1.5 m^3/s is evaporated at the top of the cooling towers. The 3 m^3/s of water which is returned has a temperature of 19.3°C upon exiting the cooling circuit, before being diluted in the discharge basin where it spends about 5 days, and lowers in temperature by 1.9°C. The final discharge into the Seine is 17.4°C. Obtained by study of a hydraulic mock-up and mathematical modeling, these figures allow the EDF to state positively that the temperature of the Seine will not be raised more than 1°C, even in the case of a low flow rate of 15 m^3/s. The only problem is that there exists no measure carried out in situ which allows verification of this hypothesis. It could perhaps be true, if the dilution were complete; but in reality, a thermal patch is formed, due to differences in viscosity between warm water and cold water. According to the GSIEN [Scientific Group for Information on Nuclear Energy], this patch could extend 150 KM and heat the water by 10°C in places. And according to the local fish companies, it is not rare to see flow rates a lot less than 10 m^3/s. For this reason, the utility plans to construct the controversial Aube dam-reservoir upstream, initially intended to stop floods and with its main function to be that of raising the flow rate during the dry period. The EDF will need to finance part of it--86 million francs. Two thousand hectares of forest and 1000 hectares of farmland will be inundated. The Basin Finance Agency estimates the EDF share at 152 million francs while the Technical Services of the Interdepartmental Institution of Dams and Reservoirs in the Seine Basin estimates it at 113 million francs.

But surely the greatest worry is caused by the radioactive discharges which accompany normal operation of a nuclear powerplant. Here it is necessary to distinguish between two sorts of effluents. Those issuing from the "nuclear island," 9000 m^3/year, are called "normally active" and, after treatment and control, go to a mixing basin where they join the "slightly active or nonactive" effluents, from 120,000 to 130,000 m^3/year. Then the mixture rejoins the Seine by the intermediary of a porous pipe system placed on the riverbed. Add to that some 84,000 curies which will be spit out each year by the smokestacks. If the power plant functions normally, without serious technical troubles, the emissions "should not," according to the EDF, exceed presently admissible standards.

In theory, no danger! All the precautions have been taken, it is true. Thanks to mathematical models, and to tests on hydraulic mock-ups of average temperature, average flow and average discharge, EDF engineers have come up with the ideal machine. Even so, the question remains: what about "non-theoretical," but accidental, leaks which the average man cannot detect?* How will the administration and the EDF react? Will Paris water be cut off, thereby risking the displeasure of 10 million Frenchmen and compromising the nuclear future of France?

*Recall the "controlled" discharge which, in 1974, contaminated Grenoble's ground water.

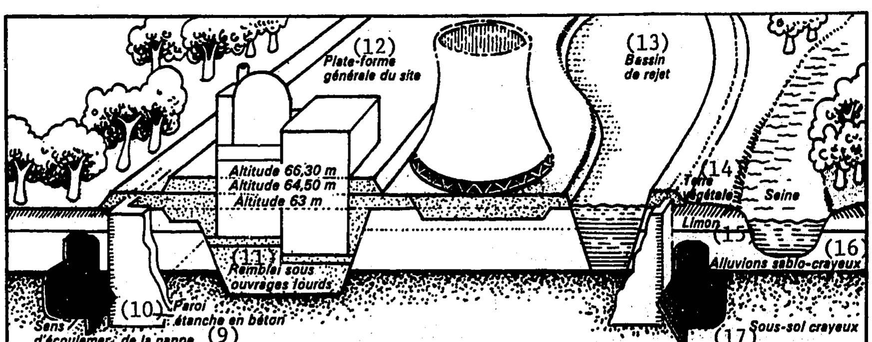
Figure 1: The Altered Substratum



(1) *Avant la centrale: l'ecoulement naturel des eaux souterraines.*

Key:

1. Before the power plant--natural flow of the subterranean waters
2. Loam
3. Clay
4. Sandy clay
5. Clay substrate
6. Level of water table
7. Direction of water flow



(8) *Après la centrale: un îlot fortifié.*

8. After the power plant--a fortified island
9. Direction of water flow
10. Watertight, concrete shell

11. Fill under heavy sections
12. General platform of the site
13. Discharge basin
14. Loam
15. Clay
16. Sandy clay
17. Clay substrate

The Nogent power plant site is part of the lowlands in the Seine valley. Under a thin layer of impermeable clay, the ground water (that which is closest to the surface) flows obliquely across sand and gravel. The water in the deeper clay level cannot really be separated from this ground water.

To ensure proper foundations for the main parts of the power plant, two gigantic works will be necessary. They require reshaping the substratum, judged to be of mediocre quality. Thus two million cubic meters of sand, gravel, and clay debris will be dug out and replaced with three million cubic meters of "good" material, found not far from the site. In order to protect it from periodic flooding, the power plant will be perched on a platform which will shelter it from thousand-year floods. In order to keep everything dry, it will be necessary to pump the water out of the excavations and pour a concrete shell all around the future power plant. The ground will be made watertight by injecting concrete into the places where the water level climbs. Although no concrete is perfectly watertight, this screen will act as protection against the subterranean water which will flow around the plant. Will leaks truly be impossible.

LES PARISIENS ACCEPTERONT-ILS LES « NORMES » ?

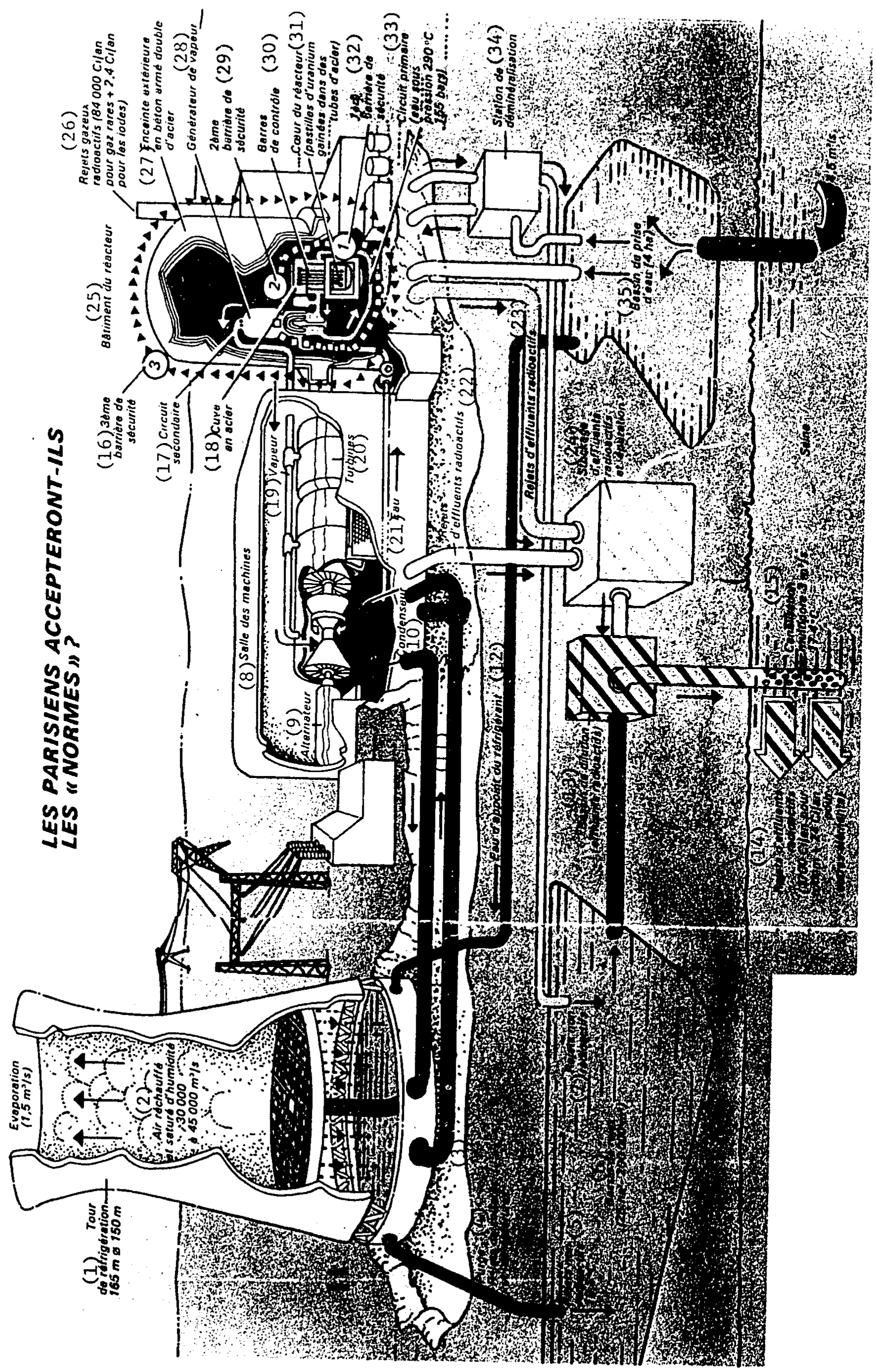


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Figure 2: Will Parisians accept the "standards"?

Key:

1. Cooling tower 165 m Ø 150 m
2. Reheated, saturated air 30,000 to 45,000 m^3/s
3. Cooling circuit
4. Drain--discharge of sulfates and chlorides
5. Non-radioactive discharges 19.3°C
6. Discharge basin (25 ha - 200,000 m^3)
7. Non-radioactive discharges
8. Machine room
9. Alternator
10. Condenser
11. Cooling circuit
12. Make-up water for cooling
13. Dilution basin (radioactive waste)
14. Discharge of radioactive wastes (3700 curies/yr for tritium + 24 curies/yr for other elements)
15. Porous pipes 3 m^3/s, 17.4°C
16. Third safety barrier
17. Secondary circuit
18. Steel vessel
19. Vapor
20. Turbines
21. Water
22. Discharge of radioactive wastes
23. Discharge of radioactive wastes
24. Storage and cleaning of radioactive wastes
25. Reactor building
26. Gaseous radioactive discharges (84,000 curies/yr for rare gases + 2.4 curies/yr for iodine)
27. Exterior casing of reinforced concrete lined with steel
28. Vapor generator
29. Second safety barrier
30. Control rods
31. Heart of the reactor (uranium pellets sheathed in steel tubes)
32. First safety barrier
33. Primary circuit (water under 155 bars of pressure, 290°C)
34. Demineralizing station
35. Water intake basin (4 ha)

The source of heat--pellets of uranium oxide, enriched to 2-3 percent, stacked in very thin tubes, nearly 4 meters in length, whose sheath of a zirconium alloy constitutes the first safety barrier. The reactor vessel constitutes the second safety barrier. To control the reaction, control rods (boron) can be inserted into the reactor core. Their role is to absorb neutrons. The heat produced by the core is transported by pressurized water to the primary circuity then given to the secondary circuit which vaporizes it by means of the vapor generator. The vapor is then released into a turbine which it turns, engaging the alternator which produces electricity. This turbo-alternator group turns a single shaft at a speed of 1500 rpm. To return to its liquid phase and start a new cycle, the vapor then passes through a condenser which itself is permanently cooled by water in a third, closed, circuit--the cooling circuit with a flow of 46.5 m^3/s for every 1300 MW. The heated water coming from the condenser is sprayed in a cooling tower where it is recooled by the ambient air and falls as rain into a recovery basin. Nevertheless, part of this water evaporates (1.5 m^3/s for the two sections) and it is necessary to replace it by means of a 4-hectare basin fed by the Seine. Likewise, 0.03 m^3/s of water is drawn from this basin, passing through a demineralizing station before proceeding to the primary and secondary circuits to replace the water lost by leaks and by continuous treatment of radioactive wastes. In all, 4.5 m^3/s are taken in, mainly for the cooling circuit. Three cubic meters per second are returned to the Seine by means of the 25-hectare basin where the water stands for about 5 days before going to a dilution tank where it joins the "controlled" radioactive wastes--those meeting the standards. Fission of uranium 235 produces new radioactive substances resulting either from the fission itself or from neutron activation of certain substances contained within the reactor. Among these radioactive substances which must be continually extracted from the circuit are tritium, impurities in the reactor's cooling water and certain elements of the steel used in the primary circuit. Among the isotopes most harmful to the environment are cobalt 60, strontium 90, and cesium 134 and 137. The wastes are then dischaged into the Seine through a diffuser lying on the riverbed. In case of accidents, the double concrete casing of the reactor building, constituting the third safety barrier, should allow isolation of the radioactive products from the surrounding terrestrial environment.

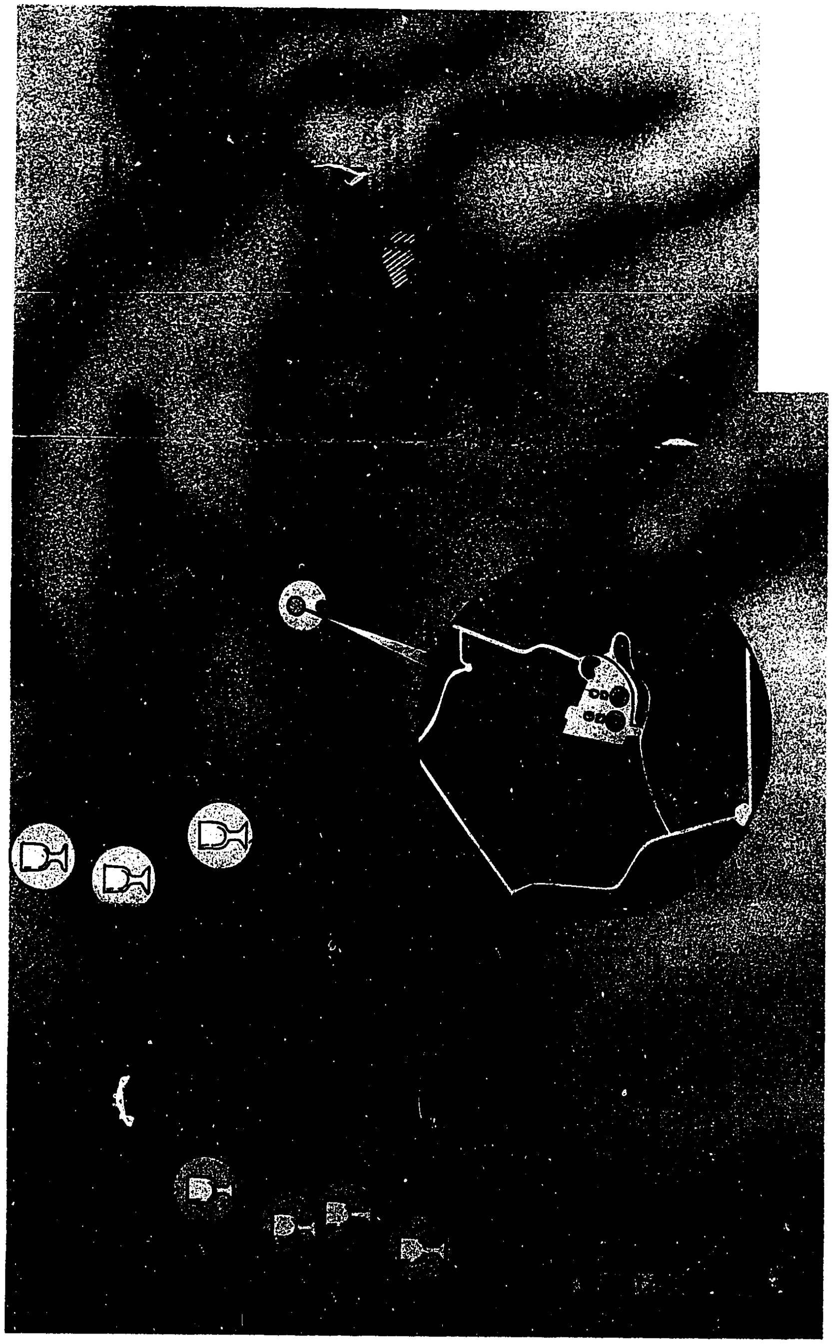

Figure 3: The public utility "forgot" 10 million inhabitants

Key:

1. Existing dam
2. Proposed dam
3. Automatic water quality monitoring
4. Water treatment plant
5. Existing recovery field
6. Proposed recovery field
7. 180,000 m^3/day
8. 800,000 m^3/d
9. 300,000 m^3/d
10. 150,000 m^3/d
11. 175,000 m^3/d
12. 55,000 m^3/d
13. North Champigny
14. 120,000 m^3/d
15. Yerres valley
16. South Champigny
17. 5 km area included in public hearing
18. Power plant site
19. Montereau subterranean water reserves 600,000 m^3/d
20. Area covered by floods of 550 m^3/s
21. Power plant
22. Future Villers-le-sec reservoir
23. Marne reservoir 350 million m^3
24. Future Aube reservoir 175 million m^3
25. Seine reservoir 205 m^3

Less than 100 km from the capital is the Parisian power plant--Nogent-sur-Seine. The water, heated and loaded with chemical and radioactive elements, which it will dump into the Seine, has every chance of being pumped by the wells or water treatment plants which supply the Parisian metropolitan area. The Seine is unquestionably the area's main water supply. This role should become more pronounced with use of the Montereau subterranean water reserves, which are supposed to guarantee the Parisians good quality water in the years to come. However, the public utility hearing only included a 5-kilometer radius around the power plant. In order to insure a sufficient flow in the Seine during the dry season, 3,000 hectares will be sacrificed to build the Aube dam-reservoir, without which the power plant cannot get along. When floods cover this region, wastes from the power plant will be spread over all the neighboring land. The standards, in terms of average doses, will be respected through dilution. There will only be a little more radioactivity in the environment!

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END